THE IMPORTANCE OF SOFT ROT BACTERIA ON POTATO PRODUCTION AND NEW DEVELOPMENTS FOR THEIR CONTROL

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In the next few years potato growers may be routinely using a new means to greatly enhance potato growth and development. This may largely result from the application of beneficial bacteria to seed potatoes, which then grow and colonize root and tuber surfaces to effectively antagonize soil-borne pathogens. The effects of beneficial bacteria on potato yield and quality were large in California field trials; yield increases ranging from 5 to 33% were reported in 12 of 16 field plots (3, 6). The beneficial bacteria were capable of rapidly colonizing root surfaces and enhancing early stolon and tuber development. Erwinia carotovora appears to be a principal soil-borne pathogen antagonized by these beneficial bacteria (2, 4). Populations of the pathogen were reduced 90 to 100% on potato roots and tubers following treatments with some strains of bacteria.

Erwinia carotovora subsp. carotovora (Ecc) and E. carotovora subsp. atroseptica (Eca) are common potato pathogens that appear to be a major constraint on yield and quality of potatoes in Washington. The diseases they cause are readily recognized by growers as seed-piece decay, blackleg, and soft stem rot. Seed piece decay and blackleg result from contamination and infection of parent seed tubers (5). Soft stem rot and storage soft rot of tubers may result from the buildup of inoculum residing in the soil. Thus, procedures aimed at limiting the growth and colonization of E. carotovora on potato plants may be the best means of controlling these important diseases. This may be achieved most effectively by using beneficial bacteria that antagonize E. carotovora on plant surfaces.

Colonization of Potato Plants

Erwinia carotovora colonized potato stems, tubers, and rhizosphere soil to high populations at three field plots in the Columbia Basin. Visible disease symptoms were not observed on sampled plants. Populations were determined at three week intervals throughout the growing season. Figure 1 shows the E. carotovora populations from stems collected at the three locations. From about June 12 to July 23 there was a steady increase of bacteria associated with healthy-appearing potato stems. Populations ranged from 10^4 to 10^5 CFU/g fresh weight of stem tissue. In early August, the maximum daily air temperature exceeded 85°F. During this period the growth potential of the potato was decreased (1); there was a corresponding decrease in the Erwinia populations. These populations returned to high levels following this period of high temperatures. It is speculated that the high temperatures were helpful in reducing pathogen levels and reducing potential disease development and premature plant senescence. Erwinia populations in the soil were not greatly affected by extreme temperatures (Fig. 2). Soil populations increased with plant growth and development to sometimes exceed 10^7 CFU/g of soil. Both Ecc and Eca were found throughout the season; Ecc was the predominant subspecies. Therefore, high populations of E. carotovora are associated with potatoes grown under normal cultural practices in Washington. Erwinia populations may be sufficiently high to limit the overall growth and development of potatoes, even in the absence of soft rot symptoms.

Biological Control

Since E. carotovora is present in high populations on potato plants throughout the growing season, their control may be achieved best by establishing some from of biological control.

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Bacteria antagonistic to E. carotovora have been isolated that significantly promote potato growth and development (2, 3, 4). In 1981, bacteria were isolated from tubers and roots of potato plants in Washington and screened for their ability to inhibit E. carotovora in vitro. The most promising bacteria isolated were fluorescent pseudomonads. Many of these bacteria strongly inhibited all strains of E. carotovora on King's medium B (zones of antibiosis ranging from 0.5 to 1.5 cm from the producer colony). Greenhouse assays show that most of these strains rapidly colonized root surfaces to populations exceeding 10^7 CFU/g root four weeks after planting (Fig. 3). The E. carotovora populations were reduced by strains 16, 39 and B10. Pseudomonas strain B 10 was found to be one of the best strains for promoting growth and increasing yields of potatoes in California and Idaho (3). Plants that did not support high populations of Erwinia appeared to be larger and to have a better developed root system. However, not all strains appear beneficial. Strains 66 and 75, despite good colonization of root surfaces, did not appear to antagonize E. carotovora in greenhouse trials.

Potential Benefits

It appears likely that growers will soon be applying beneficial bacteria to seed potatoes to increase potato production. Although this is a new area of research, results indicate that large yield increases can be achieved (3, 6). The potential benefits from using beneficial bacteria may include: (a) higher and more consistent yields; (b) control of diseases caused by E. carotovora, including seed piece decay, blackleg, and soft stem rot; (c) control of Verticillium wilt; (d) higher quality tubers with fewer deformities; (e) improved ability to store tubers; (f) reduced need for expensive fumigants; (g) greater ability to grow quality Norgold russets, a variety especially susceptible to soil-borne diseases; and (h) protection from ring rot. Therefore, there is great potential for improving the overall growth and development of potatoes in Washington. Current research is aimed at selecting and improving beneficial bacteria to help ensure that they are effective against those pathogens which are most important in Washington.

References

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Figure 1. Populations of Erwinia carotovora from potato stems at three locations.

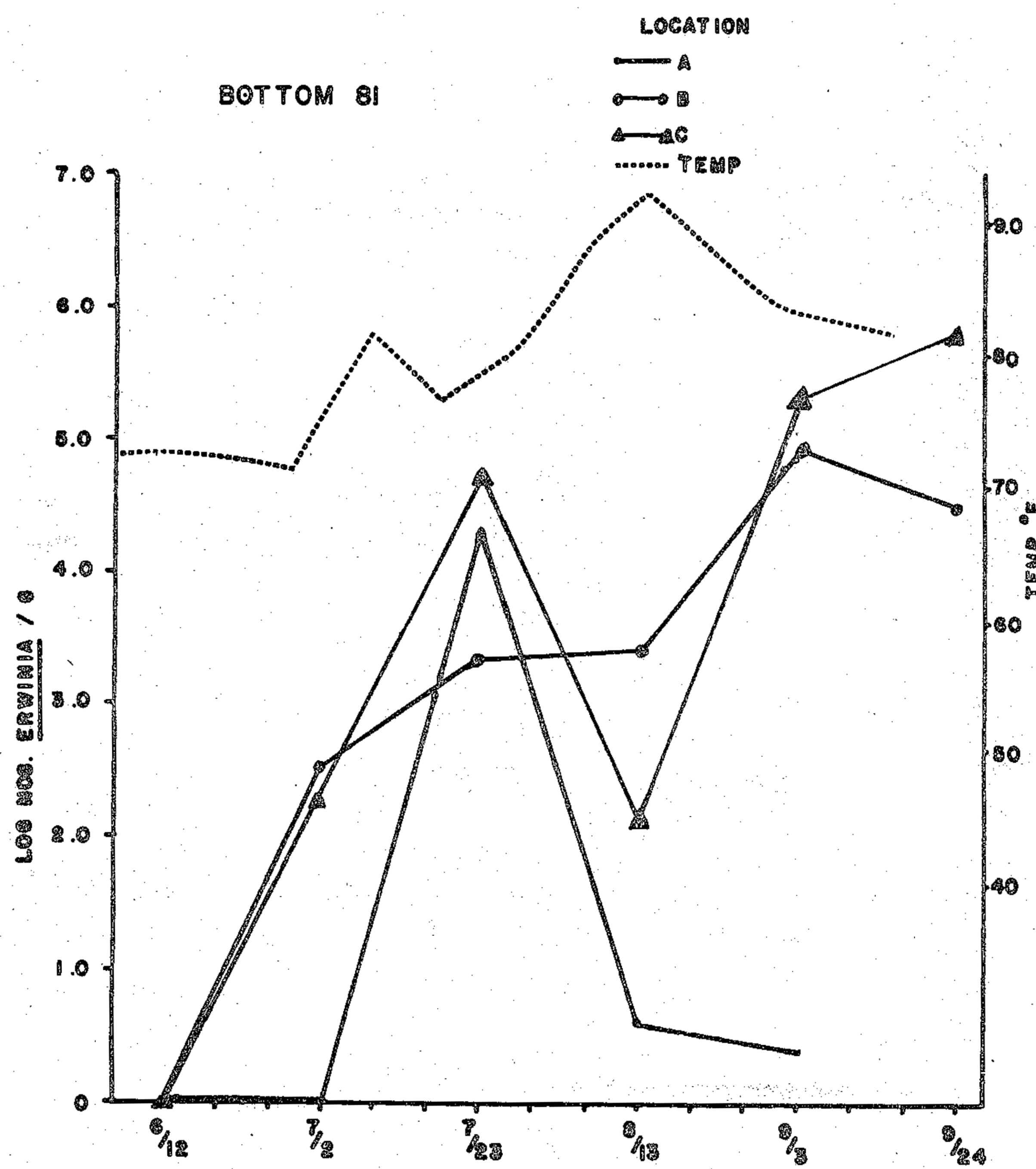

Figure 2. Populations of Erwinia carotovora in rhizosphere soils from three locations.

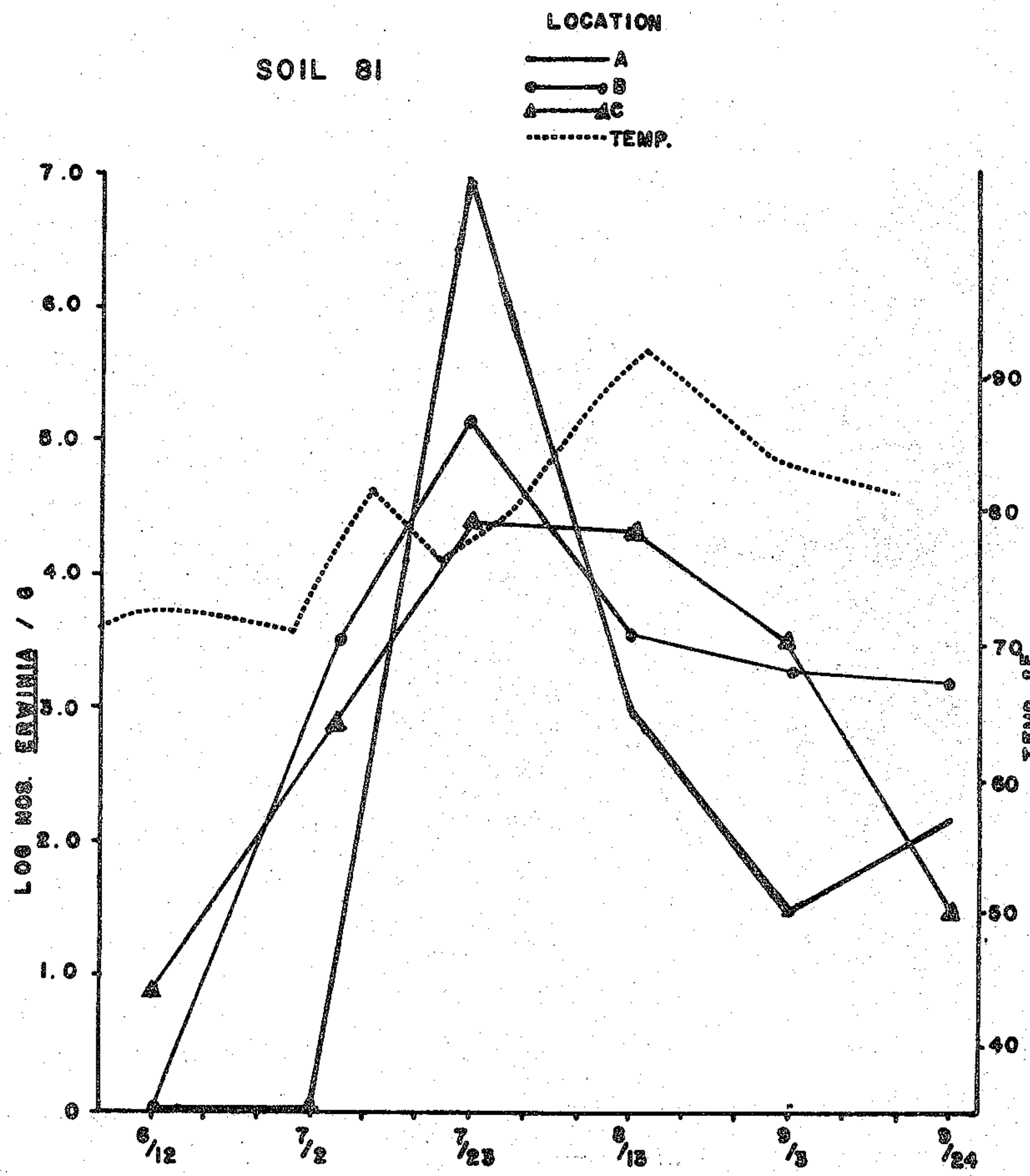

Figure 3. Antagonism of Erwinia carotovora by Pseudomonas.